by Al Williams WD5GNR

Thanks for the Memory ...

A Storage Scope for Your PC

The Velleman PCS64i has reasonable performance at a fair price.

When I worked for one of the major semiconductor manufacturers (Motorola, if you must know), I had access to all manner of fancy test equipment. When I struck out on my own, I thought I'd have to do without some of the more exotic gear. True, I don't have access to scanning electron microscopes anymore, but most common gear is now better and cheaper than what I used to use.

Over time, I accumulated scopes, meters, and even a high-speed logic analyzer. One thing I didn't get, however, was a storage scope. The analog storage scopes were not that useful. Digital storage oscilloscopes (a DSO) are nice, but they are often slow, big, and expensive. I could never find a DSO that had a decent bandwidth, at a price I could afford.

As a long-time ham, I always wanted a spectrum analyzer, but couldn't justify it as a business expense. Recently, I picked up a PC-based DSO that doubles as a spectrum analyzer. The Velleman PCS64i has reasonable performance at a fair price. I bought mine on sale for about $300.00, but even at full price you can find them for less than $400.00.

The Specs

Specifying a DSO is different than specifying a normal oscilloscope. With a normal scope, you are primarily concerned with the scope's input bandwidth. With a DSO, this is only part of the equation.

Unlike regular scopes, DSOs don't continuously monitor the input signal. Instead, they sample the signal at a certain rate. Nyquist sampling theorem dictates that if you want to sample a signal changing at frequency f, you must sample at a rate no less than 2f.

Even at twice the signal frequency, the reproduction of the signal will suffer. You can think of the sampling frequency as being similar to resolution on a printer — the higher the sample rate, the better the scope trace will look.

Of course, bandwidth is important, too. Don't forget that a scope's bandwidth indicates the frequency the scope will show a sinewave with minimal loss and distortion. If you look at squarewaves (and other non-sinusoidal waveforms), you can expect a lower useful frequency since squarewaves have many harmonics. If the harmonics are above the scope's bandwidth, the signal reproduction will suffer.

The PCS64i has a rated bandwidth of only 13 MHz. It samples at 32 MHz, although in some cases, you can oversample at 64 MHz.

The scope comes with DOS and Windows software. You connect the scope to a printer port. There is no pass through so if you want to keep your printer connected, you'll need a second printer port. While you could get an inexpensive PC and dedicate it to the scope, you'd be wise to use a relatively fast machine with a modern, fast printer port. Also, you need a math coprocessor to measure RMS voltage and do spectral analysis, so that rules out 386 and 486SX machines unless they have external

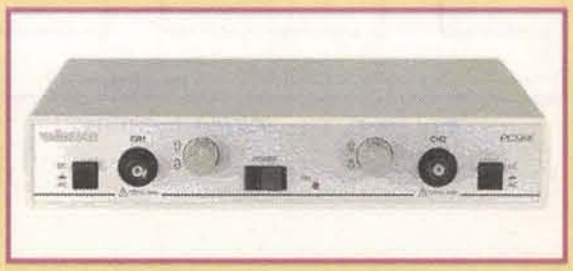

Figure 1. The PCS64i Oscilloscope

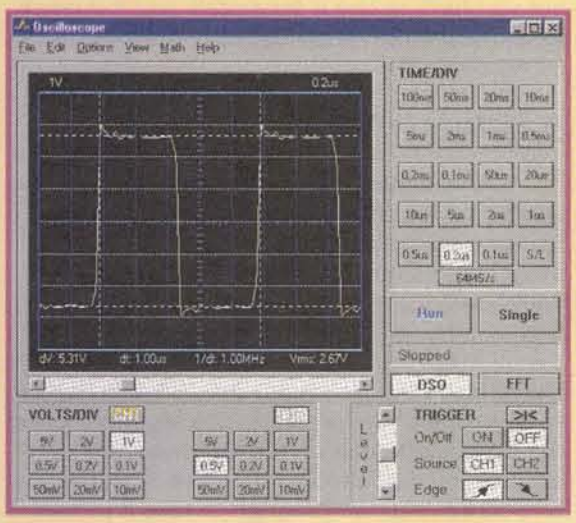

Figure 2. A 1MHz Squarewave

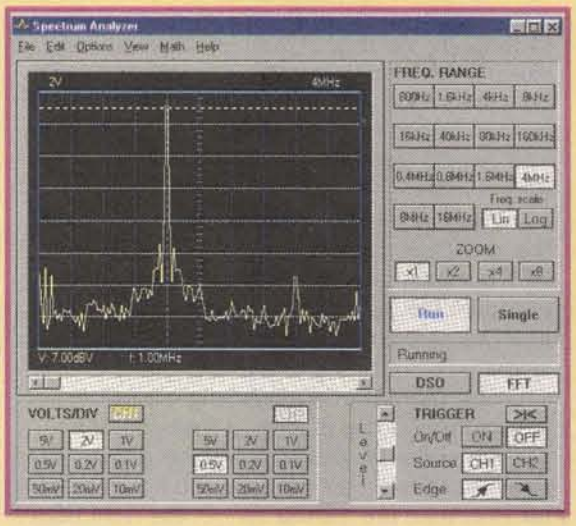

Figure 3. Spectrum Analysis

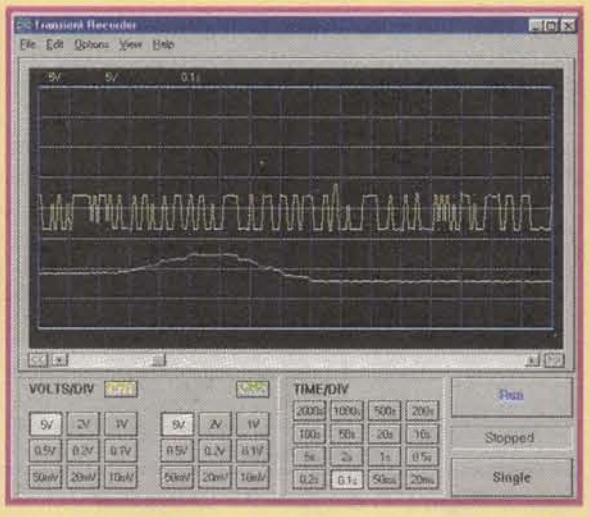

Figure 4. The Transient Recorder

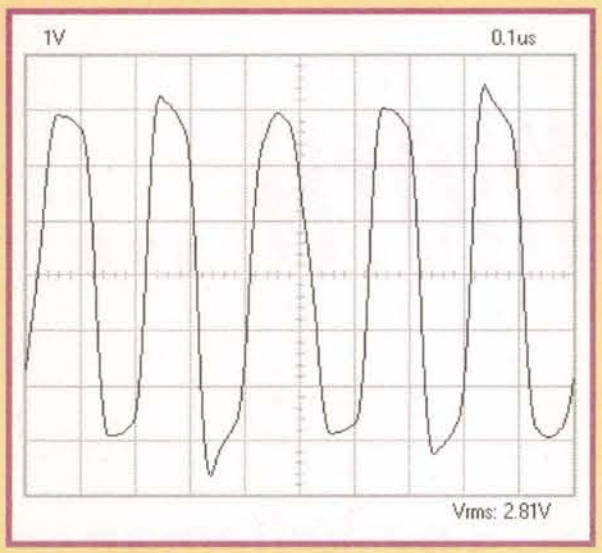

Figure 5. A 5MHz Squarewave

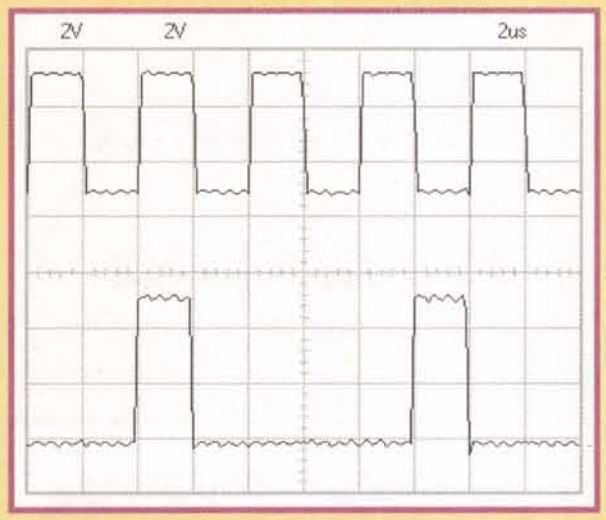

Figure 6. Two PWM Channels

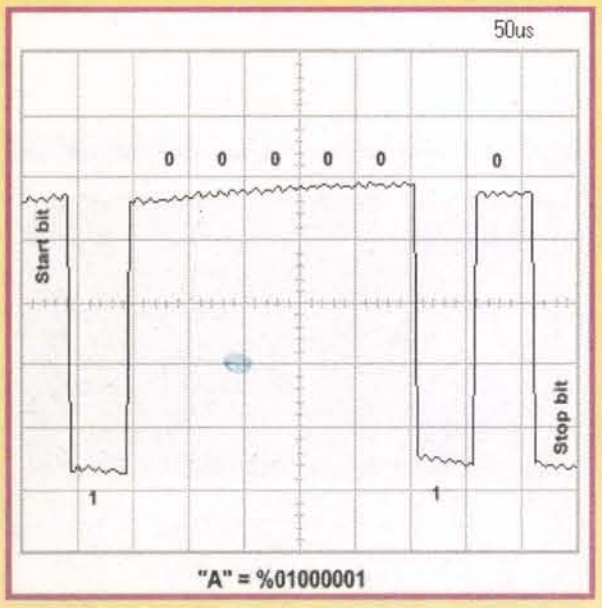

Figure 7. An RS-232 Character

coprocessor chips.

In Practice

Since the scope has no CRT or big transformers, it is lightweight. An AC adapter powers the unit (not always included, by the way — check before you buy). The front panel (see Figure 1) has a power switch, two BNC jacks, and the controls for each input. Each input has a switch to select AC or DC coupling. You can also ground the input (useful for setting a 0 reference point). There is also a knob for each input to adjust the trace position. All other settings are on the computer. Like many scopes, the PCS64i has a calibration point that delivers a known squarewave. However, the manual barely mentions it, and it is inconspicuously located on the rear panel (not the best location for it). The only marking near it is a picture of a squarewave.

Like a regular scope, you can set the PCS64i to use a trigger or run continuously. You can trigger on the rising or falling edge of either channel. A small mark on the screen shows the trigger level. When the scope detects a trigger event, it stores 4K samples for each channel. The scope stores a small number of samples ahead of the trigger and then reads the rest of the buffer. This allows you to examine the signal before the trigger and also peek at what happened just after the instrument recorded the current screen. You can also select single mode (usually when using the trigger). This causes the scope to record a single screen and stop.

If you plan to oversample, you have to use the trigger to get any sort of meaningful results. That's because oversampling looks at the waveform twice. If you don't start at the same spot each time (or if the waveform is not repetitive), oversampling is useless.

Once you have the waveform either locked on the screen or frozen, you can call up cursors to measure the voltage between points and the time between two points. The display also shows the frequency that corresponds to that time. Figure 2 shows a 1 MHz squarewave with the markers set. The scope also shows the RMS voltage at the lower right.

Notice that I'm using x10 scope probes. The software does not adjust for this, so the screen shot says the signal is about .45V. This is actually 4.5V because of the probe attenuation.

Spectrum Analysis

The spectrum analyzer works very much like the scope (see Figure 3). You can select a frequency range and use the zoom buttons to magnify an area of interest. You can also select a linear or logarithmic frequency scale. Like the scope, you can place markers on the screen. These markers measure frequency and amplitude (either absolute or relative in dB).

You can switch between the scope and the spectrum analyzer using the DSO and FFT buttons. This is handy because you can compare the signal's trace with the spectrum analysis — even after you've captured a static signal.

One thing that is confusing about the spectrum analysis display is that you don't see the entire frequency range on one screen (even at the x1 zoom factor). So if you select, for example, the 16MHz range, the right edge of the screen is really 10MHz. You'll have to use the scroll bar beneath the screen to see the rest of the frequency range.

Transient Recorder

The scope and spectrum analyzer are really the same program. However, Velleman also provides another program that they call a transient recorder (see Figure 4). This is a misleading name at best. It is really a strip chart recorder.

The idea is that this program samples the input and stores the result. Unlike the scope, it just produces a long trace for the time you specify. You can specify times as short as 20mS per division, and as long as 2,000 seconds per division. When the screen fills up, the program can automatically save the data in a file and start over.

The problem here is that the sample time is relatively slow. The exact time depends on your PC and how long you want the recorder to capture. However, the fastest you can sample in the Windows program is every 10mS. That makes it useless for all but the slowest tasks. For example, suppose you wanted to eavesdrop on a 9600 baud serial data stream. Each bit requires 104uS, so you'd need to sample at 50uS or so — several orders of magnitude less than the transient recorder can handle.

What's Missing?

While the transient recorder is useful in some cases, it isn't nearly as useful as you'd like it to be. However, the digital storage scope and spectrum analyzer are very useful — about as useful as a traditional instrument with similar specifications.

One thing I couldn't help but notice, however, is that the scope is very much like a traditional scope. It doesn't take much advantage of the computer that an ordinary scope doesn't have. For example, it'd be interesting to have the computer automatically position markers on request. Another minor annoyance is that the scope doesn't remember settings between sessions. It also doesn't know about x10 probes. There is no reason you couldn't set an option to allow the scope to display the voltage corrected for x10 probes. This is especially annoying when you save the scope's image and the voltage scale appears at the top of the screen.

The good news is that none of this is very serious. Better still, these problems could be corrected with updated software. Unfortunately, Velleman will not release the communications protocol used to talk to the device so you'd have to reverse-engineer the software or wait for Velleman to release what you want. There is a third-party program that supports this instrument called Scope-It (home.box.nl/scope-it/), but you have to buy it separately and it doesn't look much more functional than the included software.

A Picture is Worth ...

You've already seen a few pictures from the scope. In fact, that is one of the PCS64i's best features: you can capture screens and paste them into documents and presentations. You could even E-Mail them to someone else if you like, or include them on a web page. You can save a black and white image of the screen to a file by using the file menu. You can also copy a color image of the screen to the clipboard using the Copy command on the Edit menu. Of course, you can also use the Print Screen key or a screen capture program to take a picture of the entire scope.

Once you have the image, you can use a

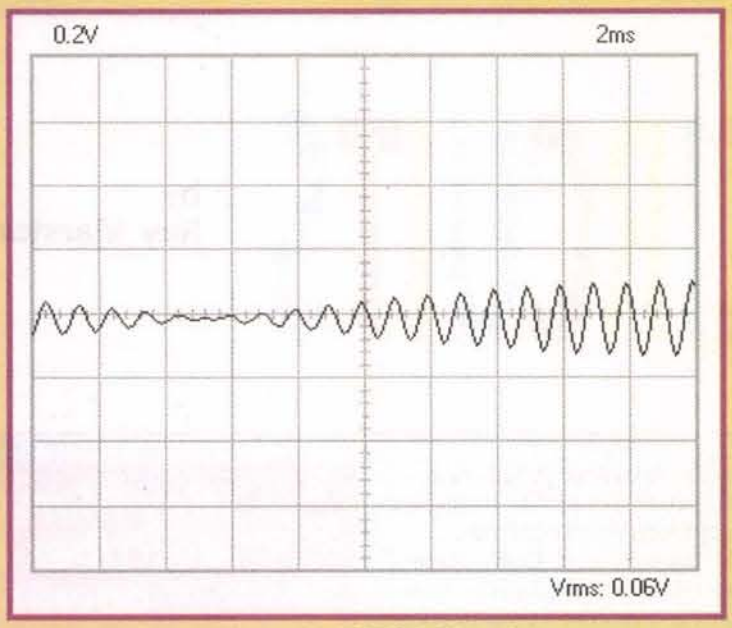

Figure 8. PSK31 Signal

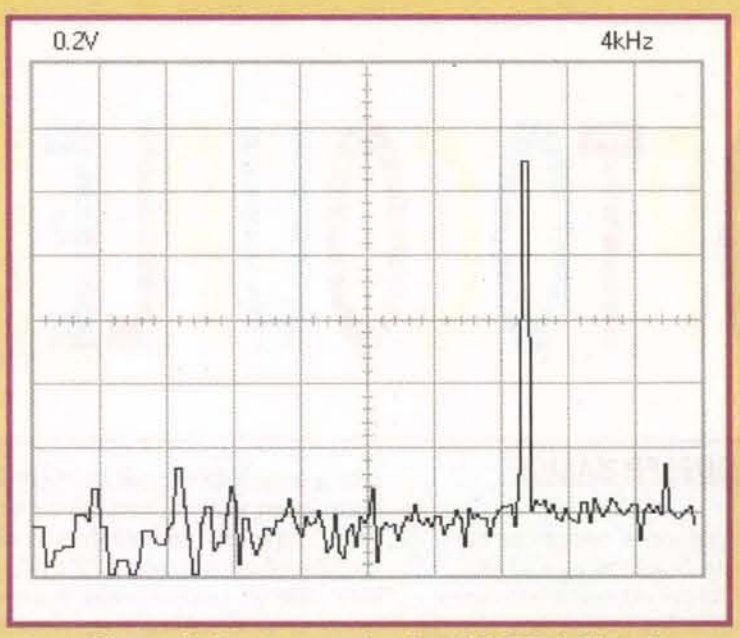

Figure 9. Spectrum of a Good PSK31 Signal

normal paint program to modify the picture. I often put a border around the image, for example. I also erase the 0.1V scale marker and replace it with 1V when I use x10 probes. If I'm using triggering, I usually erase the trigger mark on the left edge of the screen, as well.

Since a picture is worth a thousand words, here are a few to show you some of the scope's capabilities and limitations. Figure 5 shows a squarewave at 5MHz. You can see the scope's bandwidth is clipping the higher harmonics of the signal so it isn't very square anymore. However, you can still make out the signal's essentials.

Figure 6 shows two channels of pulse width modulation. The top trace has a duty cycle of 50%, while the lower trace is a 20% signal. Figure 7 shows an upper case A being sent over an RS-232 line. I annotated the areas of interest using a standard drawing program. Both Figures 6 and 7 also have additional borders drawn around them.

Finally, have a look at Figures 8, 9, and 10. These show a PSK31 signal at 1kHz (PSK31 is a phase shift keying method used by hams). Figure 8 shows the signal in the oscilloscope. Figure 9 shows the relatively clean spectrum from the signal. However, after turning the audio drive up too high, the audio amplifier begins to clip the signal. The spectrum in Figure 10 shows the story with a second peak at 3MHz (the spectrum in Figure 9 is a normal view; in Figure 10, I doubled the zoom to show the detail).

The Bottom Line

So how does the PCS64i stack up? It won't replace a traditional storage scope any time soon. However, with a price in line with a typical 20MHz scope, you might consider buying one instead of an inexpensive bench scope. True, the bandwidth isn't as high as a 20MHz unit, it is nearly as high and, in real life, you won't measure pure sinewaves anyway. For digital logic, a 20MHz scope is not too useful above 7MHz. The PCS64i will be serviceable to about 5MHz or so. However, with a 20MHz scope in this price range, you won't get digital storage, spectrum analysis, and the ability to put images easily into documents. You probably won't get on-screen measurements and true RMS voltage readings, either.

The PCS64i is certainly worth the asking price. It would be an even greater value if the scope bandwidth were higher and Velleman would provide a way for users to write their own software. If you don't have a scope, the Velleman provides a lot of bang for the buck. It makes an even better adjunct to an existing non-storage instrument. NV

Al Williams (WD5GNR) is an avid ham and divides his professional time between hardware and software designs. Al's company, AWC, is well-known for their products that augment microcontrollers, as well as for technical training. You can find out more about Al on his web site: http://www.al-williams.com/awce.

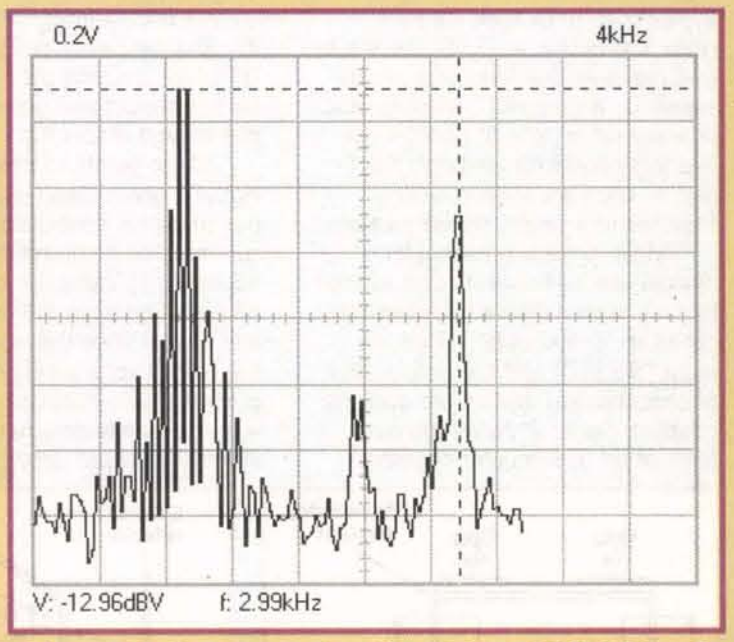

Figure 10. Spectrum of an Overdriven PSK31 Signal

PCB LAYOUT
Software For Windows - FREE
1 Download our board layout software
2 Design your 2 sided plated-through PCB
3 Send us your layout over the Internet
4 In 2-3 business days, UPS delivers your boards, often under $100
www.expresspcb.com

PIC'n Books
LEARN ABOUT PIC MICROCONTROLLERS
See Table Of Contents: http://www.sq-1.com
Secure Online Ordering Is Available
PIC is a trademark of Microchip Technology Inc.
SQUARE 1 ELECTRONICS
Voice (707) 279-8881 Fax (707) 279-8883
http://www.sq-1.com